Arkwood, Inc., Superfund Site
Comments on Tracer Study Plan

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1.	Tracer Study Plan General	Existing information (RI and original Tracer Study) indicates this site has very complex hydrogeology. However, the ROD (page 9) does identify that: "The shallow karst aquifer beneath the site may be classified as a Class IIb aquifer. While it is not currently used as a drinking water source, similar water-bearing units that discharge to springs in the area are." EPA OSWER Directive 9283.1-33, EPA Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration, June 26, 2009, states (page 3): "If groundwater that is a current or potential source of drinking water is contaminated above protective levels (e.g., for drinking water aquifers, contamination exceeds Federal or State MCLs or non-zero MCLGs), a remedial action under CERCLA should seek to restore that aquifer to beneficial use (e.g., drinking water standards) wherever practicable." Thus, to insure groundwater restoration information is included for this tracer study update and future Five Year Reviews, all wells and area springs within a 1.5 mile radius of the site should be updated with a new inventory and summarily listed with relevant details, such as the screened intervals of the well. The 1.5 mile radius is based on the previous inventory distance completed for the ROD.	The 1991 traces were regional in scale and involved dye introductions at two locations that bracketed the site. That tracing effort used a substantial quantity of dye and 79 sampling stations. No dye was detected at any wells. The regional tracing work has been completed and there is no reasonable need to conduct another regional tracing effort. The proposed new tracing is designed as a localized, non-regional scale, trace. It is designed as a quantitative dye trace from the vicinity of the former sinkhole to New Cricket Spring where pentachlorophenol (PCP), a site COC, is detected. A number of control stations are proposed to verify that there are no other points to which dye from this trace discharges. There is no credible reason to increase the scale of the proposed new tracing study to make it more regional in scope. Furthermore, based on the groundwater tracing information already available, an inventory of wells and springs within 1.5 miles of the site was previously conducted and no new wells have been installed.
2.	Tracer Study Plan General	EPA recognizes that complex karst geology exists and understands that there may be colloidal particles with dioxins attached and soluble contaminants slowly releasing to the groundwater. Additionally, the screening level has changed for dioxin in	Sampling for contaminants of concern are not a part of the dye tracing study and will not be addressed in this study. If one or more of the dyes is detected at a sampling station other than New Cricket Spring, sampling for contaminants of concern may be appropriate. Such detections are

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		soil and PCP is now required to be cleaned up to 1.0 mg/L in groundwater (see EPA's January 29, 2014 letter). Since it may have been more than two decades for area wells in this karst geology to be sampled, and the fact that current technologies and standards for dioxin (PCDD/F) and PCP are not the same as in the past, please add a sampling plan to sample wells or springs within a 1.5 mile radius of the site for site contaminants. Please provide the rationale for selection of these water quality sampling locations. Please consider whether samples should or should not be filtered.	not anticipated and are not part of this study.
3.	Tracer Study Plan General	For this dye tracer study update, please provide the rationale why each well or spring of the updated inventory will be used or not used for the dye tracing study.	This is a localized tracing effort focused on characterizing water movement from the vicinity of the former sinkhole to New Cricket Spring. As identified on page 5 of the study plan dated March 26, 2014, sampling for tracer dyes will be conducted at New Cricket Spring, Cricket Spring, water discharging from the south end of the railroad tunnel, and, depending upon flow conditions, probably at one or two additional sites in upper portions of the Walnut Creek Valley. This assumes that access to the area can be obtained. On-site wells in the vicinity of the former sinkhole will also be monitored. Based upon results from the 1991 tracing study, no other groundwater monitoring points will be needed for the currently proposed tracer study.
4.	Tracer Study Plan General	Any positive discharges of tracing dye to wells or surface water springs in the monitored sites should be analyzed for both pentachlorophenol (PCP) and PCDD/F. This will	Such sampling is beyond the scope of the tracer study. Water discharging from New Cricket Spring is treated to remove contaminants of

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		assist in determining whether or not New Cricket Spring is receiving all of the constituent contaminants discharged from the Arkwood site, or whether the receiving environment for constituent contaminants extends further than was formerly believed. See similar comments on Revised CSM (including CSM Comment No. 5, 6, and 7, regarding Figure 6 and Page 3, Paragraphs 1 and 2.)	concern, but this treatment is not expected to remove all tracer dyes. If dye were detected in springs downgradient from New Cricket Spring, it would not be indicative of contaminated water derived from the site that had somehow bypassed New Cricket Spring. The regional extent of groundwater contamination from the site is already known from the 1991 tracing study. The proposed new tracing effort does not revisit this issue.
5.	Tracer Study Plan Page 2 3rd Paragraph	The plan states that one trace was introduced south of the former woodchip pile. Please identify the exact location of this tracer test, or at least refer to a landmark that still exists.	Shown on the attached map.
6.	Tracer Study Plan Page 2 5th Paragraph Figure 1	The plan states that nine wells were drilled in the vicinity of the former sinkhole. Figure 1 shows eleven wells (i.e., A through I and two unlabeled well locations). Please clarify the nature of these two additional wells, and present in a table the screened intervals of all eleven wells.	Wells A, B, and C are approximately 25 feet deep. The lower 10 feet of the casing is slotted. Bentonite grout seal is located from a depth of about 10 feet to 2 feet below ground surface. Well D is a casing placed in the location of a former tree. The two holes without letter designations were not completed and were abandoned. See attachment for information on the wells completed in 2007.
7.	Tracer Study Plan Page 3 2nd Paragraph	The proposed volume of the tracer solution injected into the two wells near the sinkhole (10-50 gallons) is much less than the volume of the tracer in the previous tracer test. The previous tracer tests involved the dispersal of batches of fluorescein and rhodamine dye (18,000 gallons each) on the ground at the two tracer test locations. At one location (91-02), the dye was dispersed on the ground 25' past New	The northwestern dye introduction in 1991 was into flow that had discharged from New Cricket Spring, and the southeastern introduction was into a losing stream/sink. The proposed new introductions are into wells, and acceptance of a similar volume of dye and water at a similar rate

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		Cricket Spring which is northwest of the Arkwood site; and at the other location (91-01), the dye was dispersed on the ground at the southeast edge of the Arkwood site. The injection of a larger volume of tracer over a larger infiltration area is more representative of the potential transport pathways associated with previous waste management activities. Therefore, expand the area over which the tracer is released rather than just in the two proposed wells located 22 ft apart, and increase the volume of the injected dye.	cannot be achieved. Furthermore, the proposed traces are to characterize typical flow conditions for the area between the former sinkhole area and New Cricket Spring. The proposed new traces are appropriately designed for the aquifer test being performed. The tests are designed to characterize subsurface flow from the vicinity of the former sinkhole to New Cricket Spring. We have modified the planned dye introduction to use substantially more water. We plan to introduce the dye and flush water through Wells A and B. Water for the dye introductions will be provided from the deep well on site; it has a reported capacity of about 35 gallons per minute. Prior to any dye introduction we will test wells A and B with about 200 gallons of water in each to verify that they will readily accept water. We anticipate that these wells will readily accept water, but will select an alternate well if necessary. One pound of fluorescein dye mixture containing about 75% dye equivalent (a powder mixture) will be mixed with about a gallon of water and introduced into Well A. Four pounds of rhodamine WT dye mixture containing about 20% dye equivalent (a liquid mixture) will be introduced into Well B. Each of the dye introductions will be flushed with approximately equal volumes of water derived from the deep

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			well on site. This well can deliver approximately 35 gallons per minute. The existing piping or a hose will be run from the deep well to Wells A and B. As much water as possible will be introduced into these wells during a one-day work period. As an estimate, if we can deliver about 35 gallons of water per minute, and can do this for about 5 hours, this would represent a total volume of about 10,000 gallons of water or about 5,000 gallons for each well. A minimum volume of water for each well will be about 2,000 gallons.
8.	Tracer Study Plan Page 3 4th paragraph	The plan proposes introduction of dye in two wells near the former sinkhole. However, it appears there were two main areas where waste management activities occurred: (1) in the former sinkhole location, and (2) on the north side of the property where creosote and PCP/non-aqueous phase liquids (NAPLs) were managed. To more appropriately trace contaminant transport from the site, please addan additional release of a tracer in the former wood storage/process areas where a significant release of waste residuals is known to have occurred (trolley/treatment area). An alternative approach would be to release the tracer in the nearby process area and include these wells, and possibly others in the tracer test. Previously, the tracer test location 91-01 was initiated in the southeastern area of the site and	The main portion of the property has been capped with clean soil. This cover is restricted to prevent disturbance and maintain its integrity. There is no reasonable way to make a dye introduction in this area. The purpose of the proposed traces is to characterize water movement through the epikarstic zone from the vicinity of the sinkhole to New Cricket Spring. The EPA interpretation of dye movement from the 1991 tracing is incorrect. Dyed water from introduction 91-01 moved to the southeast and along the Walnut Creek Valley. No dye from this introduction moved in the northwestern drainage direction from the Site. Dye detected to the northwest of the Site was derived from Trace 91-02. This dye introduction was into the drainage channel discharging from New Cricket Spring. The tracing done in 1991, coupled with the

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		that tracer introduction resulted in no dye being measured in New Cricket Spring (sample location #17) as a result of this dye test. However, dye was measured in numerous locations on the north side of the site, suggesting that ground water located in the southeast area of the site moved to the north, not to the west towards New Cricket Spring. EPA would prefer to have a better understanding of contaminant transport in other process areas, in addition to the former sinkhole.	proposed tracing, will provide a comprehensive understanding of both regional and local groundwater movement from the site.
9.	Tracer Study Plan Page 3 4th paragraph	If the tracer test is designed to include two injection areas to represent two waste management areas, it is recommended that one dye be released into one area. Therefore, the dye measurements in New Cricket Spring would be site specific.	See response to Comment 8. Because of the remedial cap a second dye introduction area is not feasible.
10.	Tracer Study Plan Page 3 4th paragraph	Please include a description of the procedures used to measure the concentration of the tracer dyes in the aqueous samples, including the wavelength and detection limit.	The analytical protocol to be used is discussed in detail in the OUL's Procedures and Criteria document. A copy is attached. Detection limits and acceptable wavelength ranges are shown on page 13 of this document. The analysis uses a synchronous scan protocol on a spectrofluorophotometer. Concentrations are based on daily standards.
11.	Tracer Study Plan Page 3 4th paragraph	The plan proposes to inject two tracers into the former sinkhole area involving wells located 22 ft apart (i.e., wells A and B). Please provide the construction details of these wells, including screened intervals.	Wells A and B are approximately 25 feet deep. The lower 10 feet of the casing is slotted. Bentonite grout seal is located from a depth of about 10 feet to 2 feet below the ground surface.
12.	Tracer Study Plan Page 3 4th paragraph	The plan proposes to introduce the pure tracer (1 lb, 75% fluorescein; 4 lbs 20% rhodamine WT) into the well, followed by dilution water (10-50 gallons). Please clarify whether the tracer dye should be dissolved into a solution	The fluorescein dye mixture is a powder. One pound of fluorescein will be mixed with about one gallon of water before introduction. The rhodamine WT is a liquid that is not diluted prior

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		before it is injected.	to introduction. Both dye solutions will be followed with appreciable volumes of water (see response to comment 7).
13.	Tracer Study Plan Page 3 3rd paragraph & 4th paragraph	The dye injection is planned for Well A and Well B, but the plan acknowledges that these wells may be blocked. Please explain why this may be. Please clarify why injecting the tracer in these two wells would be representative of PCP transport from the sinkhole. Specifically, please clarify the screened intervals of the wells relative to the dimensions of the former sinkhole. Is there indication that wells A and B are hydraulically connected to the fracture and/or karst system? Are there well capacity data showing high permeability, indicating these wells are hydraulically connected to the fractured bedrock? Will the possibility of blockage be evaluated before the dye is placed in the wells, and what is the standard for determining whether or not the wells are considered blocked? If there is no water in a well at the time of dye introduction, then will the tracer study participants verify that the well is connected to the rest of the karst system before introducing dye?	Question A: These wells bottom in the epikarstic zone. That zone contains sediments that may have moved and blocked the well or wells. This is very unlikely, but possible. Question B: The sinkhole has been filled with concrete and capped. The sinkhole previously yielded water and contaminants to New Cricket Spring. The two wells extend into the epikarstic zone in the immediate vicinity of the former sinkhole and represent the nearest and most appropriate points for introducing dyes to replicate flow from the vicinity of the former sinkhole. Question C: The wells readily accepted water during the period when water was introduced into them to augment the flow of New Cricket Spring. The epikarstic zone should be viewed as a zone in which the limestone has been extensively modified by solution to create an integrated system of conduits conveying water in a down-gradient direction. That direction, in the vicinity of the former sinkhole, is toward New Cricket Spring. It is not accurate to view the epikarstic zone as a fractured rock aquifer, although solution has preferentially occurred along fractures.

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			Question D: The depth to the bottom of each well will be measured prior to commencement of the study. If water is present in the wells, the depth to water will be measured. As described in the response to Comment 7 the wells will be tested prior to dye introduction to verify that they will accept water.
14.	Tracer Study Plan Page 3 5th paragraph Page 5 2nd paragraph	The plan says there can be up to 26 bottles of water in the ISCO sampler, and activated carbon samples are to be collected each time a trip is made to service the ISCO. Please clarify the frequency of analyzing the water samples.	A schedule for collecting samples is identified in the revised supplemental tracer study work plan (copy attached). At a minimum, every 5th water sample collected by the automatic water sampler will be analyzed. Once one or more dyes are detectable in the water previous samples will be analyzed until there are at least 2 samples where the dye concentration is below the reportable limit. For fluorescein in water this is 0.006 ppb; for rhodamine WT in water this is 0.045 ppb. Once the dye or dyes are detected in water samples most samples will be analyzed until the end of the planned study period. Professional judgment will be used to skip samples if dye concentrations are remaining nearly constant.
15.	Tracer Study Plan Page 3 5th paragraph	Please verify that the tracer samples collected at New Cricket Spring will be collected before the ozonation treatment.	The samples for dye analysis will be collected before the water is treated by ozonation.
16.	Tracer Study Plan Page 4 3rd paragraph &	If the presence or absence of blockage is not already known and not evaluated before dye introduction, and it turns out a well readily accepts only some limited amount of dye	Dye will not be introduced into a blocked well.

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	4th paragraph	before slowing its rate or else completely stopping acceptance, then how would the mass of blocked dye be addressed in a mass balance?	
17.	Tracer Study Plan Page 5 2nd paragraph 3rd paragraph	Explain how the dye is extracted from the activated carbon and measured, and whether results can be extrapolated back to ground water concentrations.	This is discussed in detail in the OUL's Procedures and Criteria document (copy attached). Activated carbon samplers contain 4.25 grams of activated carbon. After collection, the samplers are eluted in a solution of potassium hydroxide, sodium hydroxide, isopropyl alcohol, and water for one hour. The samples are analyzed in a spectrofluorophotometer operated under a synchronous scan protocol and concentrations are based upon daily standards.
18.	Tracer Study Plan Page 5 4th paragraph	It was proposed that the tracer dyes will be sampled in the other 7 wells in the former sinkhole area. In addition, grab samples should be collected where the dye was injected. This will provide an indication of whether the dye is fully eluted from the injection wells and whether the injection wells exhibit no flow characteristic or dead zones (i.e., pulse versus slow release of the dye).	This will be done.
19.	Tracer Study Plan Page 5 5th paragraph	The plan describes how a mass balance could be calculated, but it does not indicate how the results will be evaluated. When the amounts of dye reaching the spring are compared to the amounts introduced in the wells, what will be the standard for determining that substantially all of the dye is reaching the spring? In other words, what is the expected range in percent recovery of the dye used to assess cumulative mass recovery that reflects complete capture?	Some of the mass of dye introduced will remain in close proximity to the well where it was introduced and more will be adsorbed on soil and rock surfaces. The technical literature suggests that dye traces from sinkholes to springs are typically characterized by 20 to 50% of the introduced dye being detected at the spring. The percent of recovery probably will be greater for fluorescein than rhodamine WT because rhodamine WT has a greater sorption tendency.

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		What if some significant amount of dye is unaccounted for? How will the test establish whether or not any dye bypasses known discharge points via ground water flow?	Given the amount of dye planned for use and the anticipated rapid flow from the introduction points to the spring we anticipate that the percent recovery will be near the upper limit of that typical for traces from sinkholes to springs. Rather than focusing on the mass of dye recovered, the better approach is to determine the amount of time required for 50% of the detected dye to discharge from the spring and the time required for 90% of it to discharge. Sampling for tracer dye at Cricket Spring (a site different from New Cricket Spring), in drainage from the Railroad Tunnel, and in Walnut Creek is expected to verify that none of the introduced dyes bypass New Cricket Spring.
20.	Tracer Study Plan Page 5 Paragraph 5	The plan states, "*Water samples will be analyzed only if one or both of the dyes is detected in the associated water samples."* Should that sentence refer to the activated carbon samples? Please revise this text to clarify.	Yes, the comment refers to activated carbon samplers. This typo has been corrected in the revised Supplemental Work Plan.

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